Primary thoracoscopic treatment of empyema in children

Gordon Cohen, MD, PhD
Vibeke Hjortdal, MD, PhD
Marco Ricci, MD
Adam Jaffe, MD
Colin Wallis, MD
Robert Dinwiddie, MD
Martin J. Elliott, MD
Marc R. de Leval, MD

Objective: The optimal treatment of pediatric empyema remains controversial. The objective of this study is to compare the use of conventional management versus primary thoracoscopic drainage and decortication in children with empyema.

Methods: Conventional management has consisted of chest drain insertion under general anesthesia plus intravenous antibiotics. Thoracoscopic drainage and decortication has consisted of primary thoracoscopic drainage and decortication plus antibiotics. The clinical course of 54 patients treated conventionally between 1989 and 1997 was compared with that of 21 patients treated by means of thoracoscopic drainage and decortication between September 2000 and September 2001.

Results: Results of the study demonstrated that patients in the drainage-decortication group had fewer invasive interventions per patient than those in the conventional management group (1.0 vs 1.26). Patients undergoing thoracoscopic drainage and decortication also had significantly shorter durations of intravenous antibiotic therapy (7.6 ± 1.2 vs 18.2 ± 7.5 days), chest tube drainage (4.0 ± 0.5 vs 10.2 ± 6.1 days), and hospital stays (7.4 ± 0.8 vs 15.4 ± 7.4). Moreover, there were no open thoracotomies and decortications in the thoracoscopic drainage and decortication group, whereas in the conventional management group 39% (21/54) of patients underwent an open procedure.

Conclusion: Although the 2 groups were not prospectively randomized and they were treated in different time periods, the results of this study support the use of thoracoscopic surgery as the primary therapeutic modality in children presenting with pleural empyema. This strategy appears to offer significant benefits over conventional treatment in terms of duration of treatment and the need for more invasive surgery.

From the Cardiothoracic Unit, Great Ormond Street Hospital for Children NHS Trust, London, United Kingdom

Research at the Institute of Child Health and Great Ormond Street Hospital for Children NHS Trust benefits from Research and Development funding received from the NHS Executive.

Read at the Eighty-second Annual Meeting of The American Association for Thoracic Surgery, Washington, DC, May 5-8, 2002.

Received for publication May 8, 2002; revisions requested July 8, 2002; revisions received Aug 1, 2002; accepted for publication Aug 2, 2002.

Address for reprints: Gordon Cohen, MD, PhD, Cardiothoracic Unit, Great Ormond Street Hospital for Children NHS Trust, Great Ormond Street, London WC1N 3JH, United Kingdom (E-mail: gordoncohen@yahoo.com).

J Thorac Cardiovasc Surg 2003;125:79-84

0022-5223/2003 $30.00+0

doi:10.1067/mtc.2003.88

Approximately 0.6% of childhood cases of pneumonia are complicated by the formation of pleural empyema. The incidence of empyema ranges from 0.4 to 6 per 1000 pediatric admissions. Despite this condition being relatively common, the management of empyema in children remains controversial.[1]

The American Thoracic Society has classified empyema as having 3 fairly

TABLE 1. Patient demographics

	CM group	TDD group
No. of patients	54	21
Male/female ratio	1.2:1	2:1
Age, mean ± SEM (mo)	70.8 ± 46.8	70.7 ± 14.6

distinct phases: an early exudative or pre-empyema phase (stage 1), an intermediate fibrinopurulent phase (stage 2), and a late organizing or chronic phase (stage 3).[2] Stage 1 empyema is usually characterized by a nonlocular parapneumonic effusion with fibrin deposited over all surfaces but not thick enough to prevent the lung from re-expanding when the fluid is drained. Stage 2 empyema demonstrates heavy fibrin deposits over all of the pleural surfaces, and some degree of lung trapping occurs. The fluid (if present) is usually grossly purulent and might have positive bacterial cultures. Stage 3 empyema is characterized by a thick fibrotic peel, and the lung cannot re-expand, even in the face of an emptied pleural space.

In the earliest stages pleural empyema is treated by means of chest tube drainage as an adjunct to intravenous antibiotic therapy. Progression of the empyema with the development of fibrinous adhesions and loculations makes simple drainage difficult if not impossible.[2] Chest tube drainage and intravenous antibiotic therapy might be adequate for stage 1 empyema. However, this approach is rarely effective in patients with stage 2 or 3 disease. Although there might be clinical improvement with drainage of the pleural space and antibiotic therapy, re-expansion of the entrapped lung is unlikely to occur in a significant number of cases, and this ultimately leads to surgical intervention.

Recognizing the limitations to this approach, some researchers have advocated the use of intrapleural fibrinolytic agents as a form of chemical debridement to enhance pleural drainage and to disrupt loculations. There have been 3 randomized controlled trials with intrapleural administration of fibrinolytic substances in adult patients.[3-5] Most recently, the first multicenter randomized trial of intrapleural urokinase in pediatric patients has been reported from the United Kingdom.[6]

Despite recent treatment advances in the management of pediatric empyema, there is still a significant failure rate, leading to long hospital stays and open thoracotomy. In our institution children receive a general anesthetic for placement of a chest drain. This is done for the physical and mental well-being of the patient. As such, we reasoned that because the patient was already under anesthesia and in the theater, a slightly more aggressive and thorough treatment of the empyema with thoracoscopy could ultimately be of benefit to the patient. The purpose of the present study was to determine whether early primary intervention with thoracoscopic drainage and decortication (TDD) in pediatric patients had any clinical benefit over conventional treatment (chest tube drainage, antibiotics, and observation with open thoracotomy being reserved for patients for whom medical management fails).

Methods

The study is a retrospective analysis of patients referred or admitted to Great Ormond Street Hospital for Children (London, United Kingdom) with a diagnosis of pleural empyema. The diagnosis but not the staging of empyema was based on clinical and radiographic criteria. The conventional management (CM) group consisted of all patients admitted with this diagnosis between January 1989 and April 1997. Patients in the CM group underwent conventional treatment, which consisted of initial therapy with chest tube and antibiotics alone.[7] The policy in our institution is to place all chest drains in the operating theater under general anesthesia for the physical and mental comfort of the child.

Between September 2000 and September 2001, 27 consecutive patients underwent thoracoscopic treatment of the disease. In 6 of 27 patients, a chest drain had been inserted at the referring hospital, and this was considered the primary intervention. Because the purpose of this study was to evaluate the benefit of primary TDD of pleural empyema, only those patients without a previous intervention were considered for this study. There were a total of 54 patients in the CM group versus a total of 21 patients in the TDD group.

Patients in the CM group all underwent chest radiography, and some had the addition of a chest ultrasound scan, a chest computed tomographic scan, or both. All patients in the TDD group had a computed tomographic scan of the chest before the operation and were taken to the operating theater within 24 hours of admission.

Video-assisted thoracoscopic surgical interventions and thoracotomy were performed in the operating theater under general anesthesia, with the patient in the decubitus position. On the basis of the child's size, either dual-lung or single-lung ventilation was performed. TDD was performed with 5-mm instruments and intermittent carbon dioxide insufflation when necessary. Usually, 2 or 3 incisions were made, with one used to place a reusable trocar for the camera and the second or third for grasping instruments. All trocar sites were used interchangeably. Loculations were drained during thoracoscopic visualization. Adherent lung was separated from the parietal pleura, including the diaphragm and apex of the chest cavity. The pleural debris was removed with the endoscopic grasping device or by means of extensive irrigation and suctioning. Either 1 or 2 chest drains were left behind, which were placed through 1 or 2 of the port site incisions. Postoperative chest radiography confirmed the position of the tube or tubes. Chest tubes were removed when less than 1 mL/h fluid had drained over a 24-hour period (ie, 24 mL/d).

The medical records were retrospectively reviewed for information regarding demographics, side of empyema, duration and mode of prehospital treatment, bacteriology, type and timing of invasive procedures, and hospital course. Hospital course data included total number of invasive procedures done, total number of anesthetics, number of hospital days after intervention, postprocedure days, details of the operative course, number and duration of chest tubes, and length of stay.

TABLE 2. Empyema characteristics

	CM group	TDD group
Left-sided empyema	23 (42.5%)	9 (42.8%)
Right-sided empyema	31 (57.5%)	10 (47.6%)
Bilateral empyema	0	2 (9.5%)
Positive pleural cultures	17/54 (31%)	12/21 (57%)
Most common organism cultured	*Staph aureus* 7/17 (41%)	*Strep pneum.* 4/12 (33%)

TABLE 3. Invasive interventions

	CM group	TDD group
Primary chest drain	47/54 (87%)	0
VATS	0	21/21 (100%)
Thoracotomy	21/54 (39%)	0
Procedures per patient	1.26	1.0

Results are translated into the average number of procedures per patient in each group. *VATS,* Video-assisted thoracoscopic surgery.

Data collected were entered into a computerized statistical program. Univariate statistical analysis was performed with the Student *t* test. Data are expressed as the statistical average ± SEM. A P value of less than .05 was considered significant.

Results

All patients admitted or referred to Great Ormond Street Hospital and treated for empyema during the 2 time periods were considered in this review. There were 54 admissions or referrals for empyema during the period from January 1989 through April 1997 (CM group). Of the 27 admissions or referrals for empyema between September 2000 and September 2001, 21 patients could be considered for primary TDD (TDD group). All patients in the TDD group were found to have stage 2 empyema at the time of the operation. The demographics of the 2 groups are shown in Table 1. There was a male/female ratio of 1.2:1 in the CM group, whereas the ratio was 2:1 in the TDD group. The mean age in the CM group was 70.8 ± 46.8 months, whereas the mean age in the TDD group was 70.7 ± 14.6 months. Table 2 describes the characteristics of the empyemas in the 2 groups. In the CM group there were 23 (42.5%) left-sided empyemas, 31 (57.5%) right-sided empyemas, and no bilateral empyemas. In the TDD group there were 9 (42.9%) left-sided empyemas, 10 (47.6%) right-sided empyemas, and 2 (9.5%) bilateral empyemas. Pleural fluid cultures were positive in 17 (31%) of 54 of the patients in the CM group, with the most common organism isolated being *Staphylococcus aureus* (7/17 [41%]). In the TDD group there were 12 (57%) of 21 patients with a positive pleural fluid culture, with the most common organism being *Streptococcus pneumoniae* (4/12 [33%]).

Table 3 provides data on the invasive interventions of the 2 groups. In the CM group 47 (87%) of the 54 patients had a chest drain inserted as the primary invasive intervention. There were no patients in the TDD group who had a chest drain as the primary invasive intervention. In the CM group medical management failed in 21 (39%) of the 54 patients, and thus these patients required an open thoracotomy and decortication. No patients in the TDD group required open thoracotomy. As a result of this, patients in the CM group had an average of 1.26 invasive interventions per patient, whereas patients in the TDD group had just 1.0 invasive interventions per patient. Because all chest drains at our institution are placed under a general anesthetic in the operating theater, this also translates into 1.26 versus 1.0 administrations of general anesthesia and operating theater uses per patient as well.

Compared with the CM group, the TDD group patients had a significantly shorter duration of intravenous antibiotic therapy (18.2 ± 7.5 vs 7.6 ± 1.2 days, $P < .001$), chest tubes in situ (10.2 ± 6.1 vs 4.0 ± 0.5 days, $P < .001$), and hospital stays (15.4 ± 7.4 vs 7.4 ± 0.8 days, $P < .001$), as shown in Figure 1.

There were no recurrences of empyema in either group once the patient was discharged from the hospital.

Discussion

In 1918, Graham and Bell[8] described the basic principles of empyema management: complete drainage of the purulent collection, obliteration of the empyema space, and treatment of the underlying infection. In practice these principles have largely translated into percutaneous chest tube drainage and antibiotic therapy. Unfortunately, this practice has been uniformly associated with prolonged hospital stays and a high incidence of open thoracotomy and decortication in patients who were left with trapped lung and a residual air space.

The aim of treatment is to sterilize the pleural cavity and ensure full re-expansion of the lung. Chest tube drainage and intravenous antibiotic therapy might be adequate for stage 1 empyema. However, this approach is rarely effective in patients with stage 2 or 3 disease. Although there might be clinical improvement with drainage of the pleural space and antibiotic therapy, re-expansion of the entrapped lung is less likely to occur, and this leads to surgical intervention in a significant number of cases. Recognizing this, attempts to improve medical management have been tried for over 50 years.

As early as 1949, Tillet and Sherry[9] reported the use of streptococcal fibrinolysin and streptococcal deoxyribonuclease as lytic agents in the treatment of fibrinous, purulent, and sanguineous pleural exudations. These early attempts at lytic therapy were ultimately abandoned because the early preparations lacked purity, and antibiotics and surgical tech-

GTS

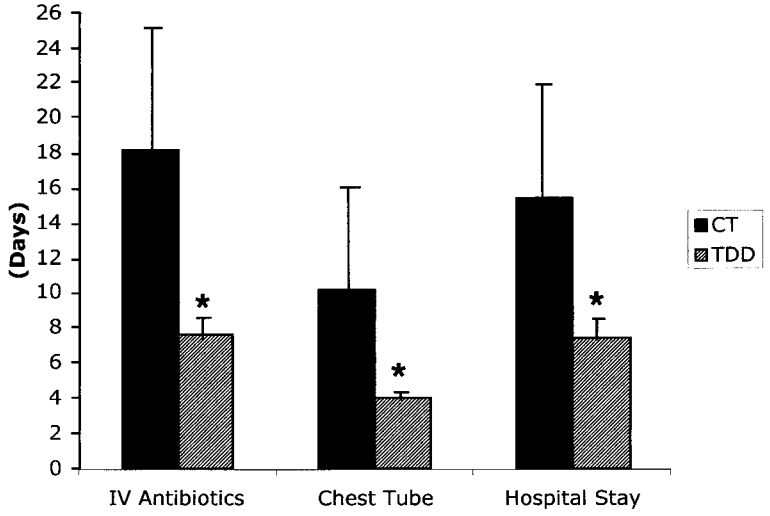

Figure 1. Clinical durations of intravenous antibiotic therapy, chest tube drainage, and hospital stay expressed as averages ± SEM.

niques improved.[10] Since then, fibrinolytic agents have been reported anecdotally in adult and pediatric patients.

Attempts at improving surgical management have also evolved in the treatment of empyema. In 1985, Hutter and colleagues[11] described a protocol of treating adult patients with empyema with the use of thoracoscopy and irrigation. Since then, technical advances in equipment have made thoracoscopy a readily available tool to the thoracic surgeon. As a result, thoracoscopy has been applied to the treatment of empyema in both adult and pediatric patients. Beginning in the 1990s, reports describing the use of thoracoscopy for the treatment of empyema in children began to surface.[12,13]

In the current era there has been a renewed interest in more aggressive medical management of empyema in an attempt to avoid long hospital stays and surgical interventions. Recently, the first multicenter randomized trial of intrapleural urokinase in pediatric patients was conducted in the United Kingdom.[6] The results of this study have led to a change in practice among many of the centers in the United Kingdom. In this study there was an approximately 10% failure of medical management, which led to open thoracotomy. Unfortunately, the results of this study might not be representative of the typical cases of pediatric empyema seen in most centers. The data from this multicenter trial demonstrated that at least one half of the patients treated were found to have clear fluid, and one third of the patients had nonloculated effusions. Thus it could be argued that by any staging criteria, these patients did not truly qualify as having stage 2 disease. As a result, these patients would have been less likely to have had unsuccessful conventional therapy and to progress to requiring more invasive treatment (ie, thoracotomy).

In contrast to the approach used by Thompson and coworkers,[6] we used thoracoscopy as the primary modality of treatment. In our series all patients had at least stage 2 empyema on the basis of radiographic criteria, and this was confirmed at the time of thoracoscopy. Our results suggest that this is an efficacious strategy for the management of pediatric empyema. We recognize that patients with clear fluid and a parapneumonic effusion (stage 1) could benefit from conventional medical treatment alone with simple drainage of the pleural space and antibiotics. However, because of the referral patterns of the patients that we see, no patients with stage 1 empyema were admitted during the period in which we used a primary thoracoscopic approach.

The strategy of using thoracoscopy as the primary modality of treatment has recently been reported, although with some differences. In 2000, Doski and coworkers[14] reported their experience with 139 pediatric patients with empyema referred for surgical therapy. In one of their 3 groups, 41 patients underwent primary video-assisted thoracoscopic surgery over a 6-year period. Similar to our study, they demonstrated a clinical benefit to patients undergoing primary thoracoscopic treatment. Their study differs from ours in that they only saw patients who were referred for surgical therapy. Our protocol called for all patients admitted or referred to the hospital during the 12-month period to undergo primary TDD.

The results of our study demonstrated a clear clinical benefit to patients undergoing primary TDD when compared with conventional therapy in the same institution. Overall, patients in the TDD group experienced significantly shorter hospital stays, fewer invasive procedures, and shorter duration of intravenous antibiotic therapy and chest tube drainage. Most significantly, the number of thoracoto-

mies that patients underwent in the CM group relative to those in the TDD group was dramatic.

In summary, the current study focuses on a specific subgroup of pediatric patients with stage 2 empyema who have undergone TDD as a primary invasive intervention. The study attempts to demonstrate that this type of approach to the treatment of empyema might have significant benefits when compared with medical management.

There are, however, limitations to this study. It is a retrospective, nonrandomized, observational study of 2 groups of patients treated in different time periods. Drawing overly strong conclusions on the basis of these limitations would be inappropriate. Despite this, there does appear to be a clinical benefit to treating all patients with primary TDD. In the current era medical specialists are increasingly using intrapleural fibrinolytic agents as an adjunct to conventional therapy. We believe that a prospective randomized trial of conventional therapy plus intrapleural fibrinolytic agents should be compared with primary thoracoscopic treatment of stage 2 or 3 empyema in the pediatric population. Such a study is already underway. The hope is that this will enable practitioners to identify which patients would most likely benefit from each of the 2 therapeutic modalities in an effort to develop a standardized protocol for the treatment of pediatric empyema.

In conclusion, initial results from this review would suggest that in the current era there might be an overall clinical benefit from treating pediatric patients with empyema with a primary thoracoscopic intervention rather than with conventional therapy with primary chest drainage only.

References

1. Khakoo GA, Goldstraw P, Hansell DM, Bush A. Surgical Treatment of parapneumonic empyema. *Pediatr Pulmonol.* 1996;22:348-56.
2. Andrews NC, Parker EF, Shaw RR, Wilson NJ, Webb WR. Management of nontuberculous empyema. *Am Rev Respir Dis.* 1962;85:935-6.
3. Chin NK, Lim TK. Controlled trial of intrapleural streptokinase in the treatment of pleural empyema and complicated parapneumonic effusions. *Chest.* 1997;111:275-9.
4. Davies RJ, Traill ZC, Gleeson FV. Randomized controlled trial of intrapleural streptokinase in community acquired pleural infection. *Thorax.* 1997;52:416-21.
5. Bouros D, Schiza S, Tzanakis G, Chalkiadakis G, Drositis J, Siafakas N. Intrapleural urokinase versus normal saline in the treatment of complicated parapneumonic effusions and empyema. A randomized, double-blind study. *Am J Respir Crit Care Med.* 1999;159:37-42.
6. Thompson AH, Hull J, Kumar MR, Wallis C, Balfour-Lynn IM. Randomised trial of intrapleural urokinase in the treatment of childhood empyema. *Thorax.* 2002;57:343-7.
7. Chan PWK, Crawford O, Wallis C, Dinwiddie R. Treatment of pleural empyema. *J Paediatr Child Health.* 2000;36:375-7.
8. Graham EA, Bell RD. Open pneumothorax: its relation to the treatment of acute empyema. *Am J Med Sci.* 1918;156:839-71.
9. Tillet WS, Sherry S. The effect of streptococcal fibrinolysin and streptococcal deoxyribonuclease as lytic agents in the treatment of fibrinous, purulent and sanguineous pleural exudations. *J Clin Invest.* 1949;28:173-90.
10. LoCicero J. Benign and malignant disorders of the pleura. In: Baue AE, Geha AS, Hammond GL, Laks H, Naunheim KS, editors. Glenn's Thoracic and Cardiovascular Surgery. 6th ed. Stamford (CT): Appleton and Lange; 1996.
11. Hutter JA, Harari D, Braimbridge MV. The management of empyema thoracis by thoracoscopy and irrigation. *Ann Thorac Surg.* 1985;39:517-20.
12. Kern JA, Rodgers BM. Thoracoscopy in the management of empyema in children. *J Pediatr Surg.* 1993;28:1128-32.
13. Silen ML, Weber TR. Thoracoscopic debridement of loculated empyema thoracis in children. *Ann Thorac Surg.* 1995;59:1166-8.
14. Doski JJ, Hicks BA, Megison SM, Sanchez P, Contidor M, Guzzetta PC. Management of parapneumonic collections in infants and children. *J Pediatr Surg.* 2000;35:265-70.

Discussion

Dr D. Wood *(Seattle, Wash).* First of all, I appreciate being allowed to be in the congenital session. I had many people ask me whether I was in the right place as I walked in, but I assured them that I was not going to be discussing an arterial switch paper. I do feel that I could talk about empyema, unfortunately, having dealt with it a fair bit.

I would like to offer my congratulations to Dr Cohen and his colleagues at Great Ormond Street for an elegantly presented article that improves our knowledge of how to care for children with pleural empyema. Dr Cohen rightly points out the obvious limitations of an observational study that evaluates 2 different treatment strategies over 2 different time periods, but this should not dissuade us from appreciating the benefit of thoracoscopic debridement, that is, a decreased duration of antibiotics, chest tube duration, and hospital stay.

However, I do not accept the apparent decrease in invasive interventions in the latter group. Although 39% of the patients receiving chest tubes required further intervention *(ie, a thoracotomy)*, 61% required a chest tube as the solo intervention, and that is clearly less invasive than the thoracoscopy that all patients received in the second time period. On a scale of invasiveness, one might actually claim that patients had fewer major interventions before the institution of thoracoscopy.

To me, it seems rather artificial that no one in the first group underwent a thoracoscopy before thoracotomy and likewise that no one in the second group had a chest tube drainage before thoracoscopy, although this was the definition of the group selected.

I agree with your conclusion that early aggressive management minimizes morbidity and hospitalization. However, an algorithm of progressively invasive procedures, promptly applied and evaluated, provides the ability to minimize invasive procedures and empyema morbidity. An efficient strategy would start with chest tube placement unless the history and imaging made it clear that this would be futile. A chest computed tomographic scan should then follow within 12 to 24 hours, and if complete evacuation and lung expansion is not accomplished, the patient should go on to a thoracoscopy. If complete lung expansion is not achieved by means of thoracoscopy, a more formal thoracotomy and decortication can be performed at the same operation. In this algorithm a definitive resolution will be accomplished within 24 to 48 hours, but some patients will also be successfully treated with tube thoracostomy alone and be able to avoid even a thoracoscopy.

Dr Cohen, why did you make such a radical treatment change in September 2000? Do you believe a short trial of chest tube drainage precludes successful thoracoscopic decortication? What clinical and radiologic characteristics do you use to decide to proceed directly to surgical intervention?

I am delighted to see your plans for a randomized trial comparing fibrinolytics with thoracoscopy. My bias is that the results will direct pediatricians to involve the thoracic surgeons early in the course of empyema management to the ultimate benefit of the patient. I applaud your fine work and your elegant presentation. Thank you for the privilege of the discussion.

Dr Cohen. Thank you, Dr Wood, for your comments and for taking time out from the session you are chairing to discuss our article.

I think that your comments about chest tube drainage as an initial invasive intervention and, giving that a chance, then followed by thoracoscopy are appropriate. However, in the pediatric population, all these invasive interventions are done under general anesthesia. Therefore, not only are we exposing the patients to a procedure in and of itself, but we are also exposing them to general anesthesia, which requires endotracheal intubation and recovery from each of the procedures.

Even the procedure of just having a thoracentesis for obtaining the fluid involves sedation; therefore, to undergo the protocol that you would propose in this situation, a child would have an initial sedation with a thoracentesis, followed by general anesthesia for placement of a chest drain, followed by general anesthesia for the thoracoscopy. Therefore, we found that we have used this aggressive and radical approach, as you might call it, to do everything at once. We take the patients as they come through the door, and, at the time they are given the first course of general anesthesia, we are able to accomplish all 3 things at once. I think we found that the invasiveness of the procedure has been greatly reduced as a result, and the patients get the one isolated intervention.

There is another benefit, and we might disagree on this. You say 61% of the patients were successfully treated with chest tube drainage alone, but conversely, it would require yet an additional period of general anesthesia for those patients to undergo a thoracotomy. Therefore, I believe that this approach eliminates a lot of these extra steps and gets right to the heart of treating the disease from the outset.

The second thing is that a double-blind, randomized, prospective, multicenter trial conducted in the United Kingdom was just recently published, looking at chest tube drainage with and without the use of intrapleural urokinase. I do not want to spend time discussing that study in detail, but they showed a slight benefit in terms of overall hospital stay if the patients received intrapleural urokinase.

That article, since being published, has caused a change in terms of the practice of the treatment of empyema in the United Kingdom. Unfortunately, I have been getting a number of patients in whom urokinase therapy has failed. The process of doing the decortication after the patient has received urokinase is made infinitely more difficult as a result of the change in the characteristics of the peel itself; it becomes much stickier and much more difficult to remove. In fact, of now greater than 50 patients who have undergone thoracoscopic treatment of empyema, the only patient who was ever converted to an open thoracotomy was a patient in whom urokinase therapy had failed.

The majority of patients we have seen have not undergone primary therapy with thoracoscopy, and a large group of patients had a chest drain in place before transfer. Those patients were excluded from this group because they were not treated primarily with thoracoscopy. However, in terms of the time of treatment, from the time we intervened when they arrived at our hospital and performed the thoracoscopy, the data are very similar to the data that I have just shown you.

Finally, in terms of the time line of our treatment regimen in addressing why we went into this specific protocol, in May 2000, we did our first thoracoscopic treatment primarily of empyema. But between May 2000 and September 2000, patients were just randomly treated with no specific protocol. They either received conventional therapy or thoracoscopic treatment, and there was no specific manner in which it was taken.

Then we decided in September 2000 to implement a policy of taking every patient that came into the hospital with empyema and treating them only thoracoscopically. During that period, there were 27 patients who were admitted, but 6 of those patients had a chest tube already in place at the time of transfer and, therefore, only 21 of those patients could be considered for primary thoracoscopic treatment.

At the conclusion of this, and this is also in relationship to the article that was just recently published on the use of intrapleural fibrinolytics, we decided to embark on a randomized prospective trial to determine which was better, primary thoracoscopy or chest drain with intrapleural fibrinolytics. Therefore, between September 2001 and the present, patients have been randomized to each of these 2 groups.

Dr A. Laudito *(Jackson, Miss)*. I want to congratulate you for the data that you presented, but I believe we are arguing between 2 alternatives that are part of our armamentarium to treat this problem. First, if you are having fresh empyemas, the thoracoscopic approach is very successful, as you brilliantly described. However, in old organized empyemas, your results are not going to be so successful, like a minithoracotomy, where you can directly remove a difficult peel. Second, I do not know how many of the present pediatric cardiac surgeons request general anesthesia to place a chest tube in a neonate, in infants, or in pediatric patients.

Dr Cohen. I appreciate your comments. I think that the reason for the general anesthesia is not for the surgeon but rather for patient comfort, and it is a general protocol in our hospital for all pediatric patients. It has nothing to do with what the surgeon needs or does not need.

(Slide) In terms of the result that we get, this slide shows that same patient on postoperative day 3, and I think the result actually is very good. I am not sure that a much better result can be obtained by waiting for the peel to mature and then stripping the peel off through a thoracotomy. In fact, we have done it thoracoscopically, and it is much more difficult to do, although it can be done.

Dr Laudito. My point is that according to the stage of empyema, you can apply a different treatment.